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EFFECT OF IRRIGATION REGIME, SEED AND FERTILITY LEVELS ON YIELD ATTRIBUTES, YIELD AND ECONOMICS OF WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

A field experiment was carried out during the Rabi season of 2018-19 and 2019-20 at the research farm of R.K. (P.G.) College, Shamli (U.P.), with three replications under split-split plot design, Taking irrigation at four physiological stages (CRI, Late jointing, flowering and dough) and at six physiological stages (CRI, late tillering, Late jointing, flowering, milking and dough) as main plot, three seed rates (100,120 and 140 kg seed/ha) as sub plot and three fertility levels (F1: 100 kgN: 50kgP2O5:40kgK2O, F2: 125kg N: 62.5kgP2O5 :40kgK2Oand F3:150 kg N: 75kg P2O5:40kg K2O) as sub-sub plot. Interaction between irrigation levels and seed rates, irrigation levels and fertility levels for grain yield was significant. Irrigation at six physiological stages resulted in significantly higher grains yield (5.25 t/ha), harvest index (0.46), effective tillers/m2(426.09),spike length (11.4 cm), spikelets per spike (19.6),grain per spike (53.9), grain weight per spike (2.3 g) and 1000 grain weight (44.6). The plots receiving irrigation at six physiological stages resulted (16.41%) higher grain, (5.21%) straw and (10.45%) biological yield over four irrigations. Seed rates of 100 kg/ha resulted in 8.10 percent higher grain yield over 140 kg seed/ha. Whereas, application of 125 kg N: 62.5 kg P2O5: 40 kg K2O/ha resulted in 13.51%,17.64% and 15.70% higher grain, straw and biological yield, respectively over 100kg N: 50kg P2O5: 40 kg K2O/ha. The yield between 125 kg N: 62.5 kg P2O5: 40 kg K2O/ha to 150 kg N: 75 kg P2O5: 40 kg K2O/ha were statically at par. Irrigation at all six physiological stages resulted in 33.22% higher net return over four irrigations whereas, the application of 125kg N: 62.5kg P2O5: 40 kg K2O/ha resulted in 4% higher net return over 100 kg N: 50kg P2O5: 40 kg K2O/ha.

KEYWORDS: Fertility levels , Irrigation, Seed rates, Wheat, Yield

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INTRODUCTION

Wheat (Triticum aestivum L.), is the most important of all cereals used as a food grain in the world. Globally, wheat covers an area of 215.90million ha with a production of 765.7 million tonnes (mt) (Anonymous 2019-20). In India, wheat is cultivated in almost all parts of the country and occupies 31.45 million ha with the production of 107.6 million tones with average productivity of 3421 kg/ha and contributes 12 percent to the total wheat production of the world (Anonymous 2019-20).

There are several factors responsible for low yield of wheat, but insufficient irrigation and poor crop nutrition are the most important. Water is essential for achieving the potential yield of any crop at every development phase starting from seed germination to plant maturation. There is a positive correlation between grain yield and irrigation frequencies Kumar *et al*.,(2012).Limited irrigation often reduces grain yield due to lower test weight. Withholding irrigation at any growth stage prior to an thesis had detrimental effect on most of the growth characters. Moisture stress is also detrimental to different yield attributes. Thus efficient water management, being

one of the key agronomic management practices, not only leads to improved crop productivity, but also minimizes susceptibility from diseases and insect pests (Singh *et al.*, 2011). Fertilization also plays an important role in increasing yield and improvement in the quality of crops. High yielding varieties of wheat have been found highly responsible for higher doses of fertilization. The efficiency of both nitrogen and phosphorus is greatly enhanced in the presence of each other (Stove and Tonev, 2003).

MATERIALS AND METHODS

A field experiment was conducted during the Rabi season of 2018-19 and 2019-20 on sandy loam soil at the research farm of R.K. (P.G.) College, Shamli, and (U.P.). A composite representative soil sample was collected from the experimental field prior to the start of the experimentation and analyzed for different physic-chemical properties of soil. The soil of the experimental field was low in organic carbon, total and available nitrogen, and medium in P and K, and was slightly alkaline in reaction. The experiment was conducted to find out the ideal does of seed and fertilization under different irrigation regimes, and also to study the interaction between irrigation regimes to seed rate, seed rate to fertilization and also between fertility levels to irrigation regimes. The experiment comprised of three factors *viz.* two irrigation levels [I_1: Irrigation at four physiological stages (CRI, Late jointing, flowering and dough)and I_2: Irrigation at six physiological stages (CRI, Late tillering, Late jointing, flowering, milking and dough)as main plot treatments.], three seed rates (100,120 and 140 Kg seed /ha) as sub-plot and three fertility levels(100kgN :50kg P_2O_5:40kg K_2O, 125kgN :62.5kg P_2O_5 :40 kg K_2O and 150kgN : 75kg P_2O_5:40kg K_2O) as sub-sub-plot treatments under three replication in three factor split plot design. Standard procedures were followed during plant and soil samplings. Calculation of consumptive use of water was done as a procedure suggested by Dastane(1967). Observation on plant growth and yield were taken as per standard procedures. Gross and net returns were calculated based on the grain and straw yield and their prevailing market price of wheat during the respective crop seasons. The data obtained from the experiment were statically analyzed using F-Test as per standard procedure and LSD values at $P_{0.05}$ were used to determine the significance of differences between treatment means. The data analysis was done using advanced SAS data analysis software.

RESULT AND DISCUSSIONS

Yield Attributes

Irrigation had a significant effect on different yield attributes (Table 1). Irrigation at six physiological stages resulted in significantly higher number of effective tillers (426.09m^2), spike length (11.45cm), spikelets per spike (19.61), number of grains per spike (53.90), grains weight per spike(2.35gm) and 1000 grain weight (44.58gm). This could be attributed to overall better growth of the crop and ever maintenance of translocation of nutrients from the soil to sink and also due to maintenance of higher rate of assimilating synthesis and translocation from source (leaves) to sink (ear) even during the later period of growth. The result corroborates the finding of Kumar *etal*, (2016). Seed rates also affected the yield attributes significantly (Table 1). Highest number of effective tillers (435.07m^2) was noticed with 140 Kg seed/ha whereas, highest spike length (11.53cm), spikelets per spike (19.92), grains per spike (55.13), grain weight per spike (2.41gm) and 1000 grain weight (45.15gm)were observed under 100kg seed/ha. Seed rate of 100Kg/ha proved best probably because of less plant to plant competition for space, nutrients and also for moisture. The results are in accordance with the findings of Jha *et al.*, (2020). Fertility levels too had significant effect on yield attributes of wheat (Table 1). Application of 150 kg N: 75 kg P_2O_5:40 kg K_2O, resulted in highest effective tillers (428.71m^2), spike length (11.54cm), spikelets per spike (19.65), and grains per spike (53.64), grain weight per spike (2.71gm). This could be attributed to the ever availability ofnutrients

(NPK) even during the terminal stage of the growth and probably maintenance of higher chlorophyll content in leaves from the very beginning to up to maturity of the crop. Thus plants maintained higher and sustained rates of photo-assimilate production throughout their life. However, highest 1000-grain weight (45.36g) was noticed with 125 kg N:62.5kg P_2O_5:40 kg K_2O level. Higher 1000 grain weight with 125 kg N:62.5kg P_2O_5:40 kg K_2O might be because of relatively less competition within the plants for photo-assimilates during the grain filling period, similar results were reported by Hussain *et al.*, (2002).

Interaction

Interaction with irrigation levels and seed rates on grain yield was significant, irrigation at six physiological stages with a seed rate of 100kg/ha resulted in highest grain yield (5.54t/ha) (Table 4). This could be attributed to the ever availability and best utilization of water and the environment (plant destiny). Further, the interaction of irrigation levels and fertility levels on grain yield was also significant. Irrigation at six physiological stages with a fertilizer dose of 150kgN:75kg P_2O_5:40 kg K_2O resulted in significantly higher grain yield (5.43t/ha) (Table 5). This could be attributed to the ever availability of moisture and nutrients through the life period of the crop. Thus plants might maintainhigher pace of photosynthesis even during the grain filling stage enabling the plants to produce higher biomass as well as grain yield.

Yield and Harvest Index

Yields also were significantly influenced due to irrigation, seed and fertility levels (Table 2).Irrigation at six physiological stages resulted in significantly higher grain (5.25t/ha),straw(5.94t/ha), biological yield (11.50t/ha) and harvest index (0.469). This could be attributed to the positive influence of irrigations on yield attributes and also due to ever maintenance of higher pace of photo-assimilate production during the grain filling stage.

Similarly, 100 kg seed /ha resulted in highest grain yield (5.19t/ha) and harvest index(0.464). This could be attributed to higher value of different yield attributes with 100 kg seed/ha However, highest biological yield (11.78t/ha) and straw yield (6.98t/ha) were observed with 140 kg seed/ha.The highest value of biological and straw yield with 140kg seed/ha could be attributed to higher plant density with 140 kg seed /ha. Fertility level of 150kgN:75kg P_2O_5:40kg K_2O resulted in significantly higher grain yield(5.38t/ha), straw yield (6.61t/ha) biological yield (11.99t/ha) whereas, highest harvest index (0.469) noticed with 100kgN:50kg P_2O_5:40 kg K_2O/ ha.Higher value of grain, straw and biological yield with 150kgN:75kg P_2O_5:40 kg K_2O/ha was largely attributed to higher value of different yield attributing character due to ever and adequate supply of N and P throughout the life cycle. However, higher value of harvest index with 100kgN:50kg P_2O_5:40 kg K_2O/ha could be due to relatively low biomass production. The results are analogous to the findings of Tejbal Singh *et al.*, (2018).

Water use Parameters

Irrigations at six physiological stages resulted in highest field water use efficiency (135.6kg/ha cm). This could be attributed to significantly higher grain yield under this treatment and relatively little increase in overall consumptive use of water (38.7cm) over irrigation at four physiological stages *viz.*,CRI, Late jointing, flowering and dough(132.25kg/ha cm) (Table 3, Fig.1). The higher CUW also was noticed with irrigation at six physiological stages (38.7cm). This was probably due to higher biomass and photo-assimilate production with six irrigations. Seed rates of 100 Kg/ha resulted in the highest field water use efficiency (146.6kg/ha cm water) whereas, highest consumptive use of water (37.1 cm) was recorded with 140Kg seed/ ha. Higher FWUE with 100kg seed/ha could be attributed to higher grain yield and less consumptive use of

water. Whereas, higher consumptive use of water with 140kg seed/ha might be due to higher biomass production. Application of 125 kg N: 62.5 kg P_2O_5: 40 kg K_2O/ha resulted in highest water use efficiency (139.2 Kg/ha cm) followed by 132.83 kg/ha cm with 150 kg N: 75 kg P_2O_5: 40 kg K_2O/halevel. However, highest CUW (40.50 cm) was registered under 150 kg N: 75 kg P_2O_5: 40 kg K_2O/ha. Highest FWUE with 125 kg N: 62.5 kg P_2O_5: 40 kgK_2O/ha could be due to higher yield and relatively low CUW. Highest CUW (40.50cm) with 150kg N: 75kg P_2O_5:40kg K_2O/ha was attributed to highest requirement of water for the production of photo-assimilates to reach record tones of biological (11.99t/ha) yield.

Economics

Irrigation at six physiological stages resulted in highest net return (₹ 51,336.00) and B: C ratio (2.24) (Table 3, Fig 2). This could be attributed to comparatively higher grain yield and slightly higher cost incurred under this treatment. Seed rate of 120kg/ha resulted in the highest net return (₹ 46,560.00) whereas, B: Cratio (2.29)was recorded highest under 100kg seed/ha. The higher net return with 120kg seed /ha was due to higher straw yield whereas, highest B:C ratio with 100 kg seed was due to higher grain yield and comparatively less cost of production. Fertility level of 125kg N: 62.5kg P_2O_5: 40kg K_2O/ha resulted in highest net returns (₹ 45,187) B: C ratio (2.31). This could be attributed to comparatively the higher grain yield and the low cost incurred in comparison to 150kg N: 75kg P_2O_5: 40kg K_2O/ha.

CONCLUSIONS

Applying irrigation at four physiological stages (CRI, Late jointing, flowering and dough) is not sufficient to achieve the potential productivity of high yielding wheat varieties. Even in high yielding wheat varieties also the seed rate is required to be kept 100kg/ha. To achieve the potential yield in wheat under conditions of assured irrigation, the crop is required to be fertilized with 125kg N: 62.5kg P_2O_5: 40kg K_2O/ha, this not only help to boost production but is also helpful in achieving the highest farm profit per unit of area.

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Table 1:Yield Attributes of Wheat Cv. PBW677, asin Fluenced by Irrigation Level, Seed and Fertility Levels (Pooled Data of Two Years)

Treatment	Number of effective tillers/m^2	Spike length(cm)	No. of spikelets /spike	No.ofgrains /spike	Grainweight/spike(g)	1000 grain wt.(g)
Irrigation level						
I_1:Irrigationatfour physiological stages (CRI, Late jointing, Flowering and Dough)	391.01	11.03	19.05	50.59	2.17	41.41
I_2: Irrigationatsixphysiologicalstages (CRI, Late Tillering, Late jointing, Flowering, Milking and Dough)	426.09	11.45	19.61	53.90	2.35	44.58
SEm ±	8.25	0.093	0.125	0.711	0.038	0.705
CD(P=0.05)	34.05	0.38	0.515	2.934	0.156	2.909
Seedrate (kg/ha)						
S_1:100kg/ha	392.41	11.53	19.92	55.13	2.41	45.15
S_2:120kg/ha	398.16	11.14	19.19	50.92	2.20	42.55
S_3:140kg/ha	435.07	11.05	18.89	49.68	2.17	41.14
SEm ±	12.96	0.122	0.421	1.316	0.061	0.912
CD(P=0.05)	34.06	0.32	1.106	3.459	0.160	2.397
Fertility level (kg/ha)						
F_1:100 kg N: 50 kgP_2O_5:40 kg K_2O	396.40	10.99	19.07	51.34	2.18	41.56
F_2:125 kg N: 62.5 kgP_2O_5:40 kg K_2O	400.54	11.20	19.28	51.75	2.38	45.36

F_3: 150 kg N: 75 kgP_2O_5:40 kg K_2O	428.71	11.54	19.65	53.64	2.71	41.92
SEm ±	10.23	0.099	0.119	0.632	0.069	0.896
CD(P=0.05)	24.74	0.239	0.287	1.529	0.166	2.167

Table 2: Biological, Grain, Straw yield and Harvest Index as Influenced by Irrigation Regimes, Seed Rate and Fertility Levels in Wheat Cv. PBW677 (Pooled data of two years).

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Biological Yield (t/ha)	Harvest index
Irrigation level				
I_1:Irrigationatfour physiological stages (CRI,Late jointing, Flowering and Dough)	4.51	5.94	10.45	0.432
I_2: Irrigationatsixphysiologicalstages (CRI,Late Tillering, Late jointing,Flowering, Milking and Dough)	5.25	6.25	11.50	0.456
SEm±	0.08	0.20	0.23	0.003
CD(P=0.05)	0.33	NS	0.95	0.012
Seedrate (kg/ha)				
S_1:100kg/ha	5.19	5.91	11.10	0.467
S_2:120kg/ha	4.95	6.80	11.75	0.421
S_3:140kg/ha	4.80	6.98	11.78	0.407
SEm±	0.11	0.14	0.22	0.003
CD(P=0.05)	0.29	0.37	0.58	0.008
Fertility level (kg/ha)				
F_1:100 kg N: 50 kgP_2O_5:40 kg K_2O	4.66	5.27	9.93	0.469
F_2:125 kg N: 62.5kgP_2O_5:40 kg K_2O	5.29	6.20	11.49	0.460
F_3: 150 kg N: 75 kgP_2O_5:40 kg K_2O	5.38	6.61	11.99	0.448
SEm±	0.11	0.22	0.33	0.003
CD(P=0.05)	0.26	0.53	0.79	0.007

Table 3: Consumptive use of Water, Field Water use Efficiency and Economics of Wheat Cv. PBW 677, as Influenced by Irrigation Regimes, Seed and Fertility Levels (Pooled Data of Two Years).

Treatment	CUW (cm)	FWUE (kg/hacm)	Net Return (₹/ha)	B:C ratio(₹:₹)
Irrigation level				
I_1:Irrigationatfour physiological stages (CRI,Late jointing,Flowering and Dough)	34.1	132.25	34,284	2.24
I_2: Irrigationatsixphysiologicalstages(CRI,Late tillering,Late jointing,Flowering, Milking and Dough)	38.7	135.65	51,336	2.21
Seedrate (kg/ha)				
S_1:100kg/ha	35.4	146.60	46,487	2.29
S_2:120kg/ha	36.7	134.87	46,560	2.23
S_3:140kg/ha	37.1	129.38	43,133	2.00
Fertility level (kg/ha)				
F_1:100kgN:50kgP_2O_5:40kgK_2O	35.7	130.50	43,460	2.30
F_2:125kgN:62.5kgP_2O_5:40kgK_2O	38.0	139.20	45,187	2.31
F_3:150kgN:75kgP_2O_5:40K_2O	40.5	132.83	43,960	2.05

Table 4: Interaction of Irrigation Levels to Seed Rates on Wheat Yield of Cv. PBW 677 (Pooled Data of Two Years)

Treatment	Grainyield(t/ha)	
	I_1: Irrigationatfour physiologicalstages (CRI, Late jointing, Flowering and Dough)	**I_2: Irrigationatsix physiologicalstages (CRI, Late Tillering, Late jointing, Flowering, Milking and Dough)**
Seed rate (kg/ha) S_1 :100 kg seed /ha	4.81	5.54
S_2 :120 kg seed /ha	4.42	5.17
S_3 :140 kg seed /ha	4.28	5.02
SEm±	0.07	0.15
CD(P=0.05)	0.29	0.39

Table 5: Interaction between Irrigation to Fertility Levels on Wheat yield of Cv. PBW 677(Pooled Data of Two Years)

Treatment	Grainyield(t/ha)	
	I_1: Irrigationatfour physiologicalstages (CRI,Late jointing, Flowering and Dough)	**I_2: Irrigationatsix physiologicalstages (CRI, Late Tillering, Late jointing, Flowering, Milking and Dough)**
Fertility levels (kg/ha) F_1:100kgN: 50kgP_2O_5: 40kgK_2O	4.21	5.11
F_2:125kgN:62.5kgP_2O_5:40kgK_2O	4.53	5.21
F_3:150kgN: 75kgP_2O_5: 40kgK_2O	4.77	5.43
SEm±	0.08	0.17
CD(P=0.05)	0.19	0.41

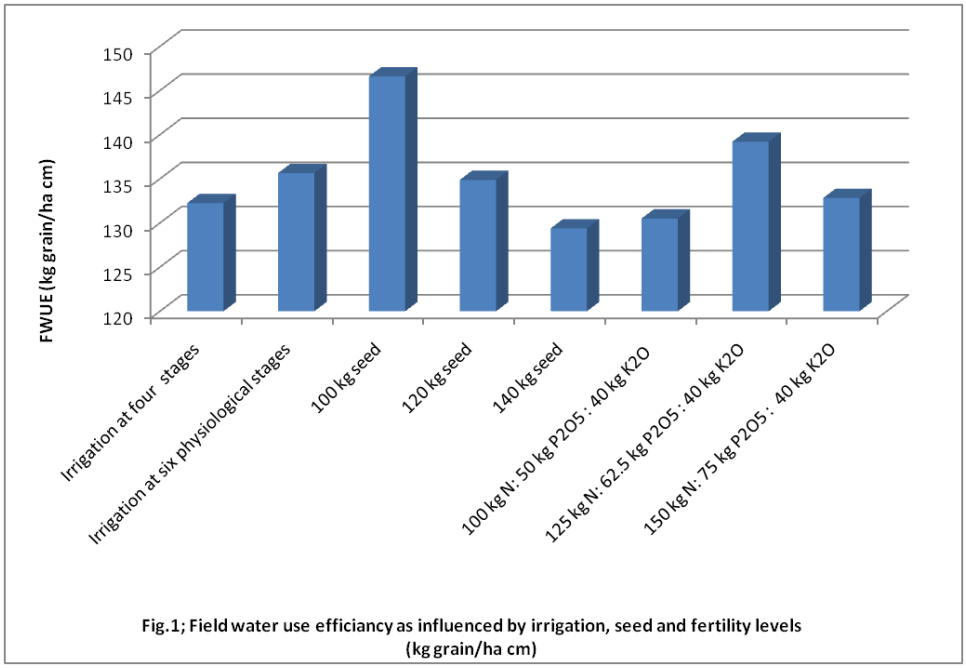

Fig.1; Field water use efficiancy as influenced by irrigation, seed and fertility levels (kg grain/ha cm)

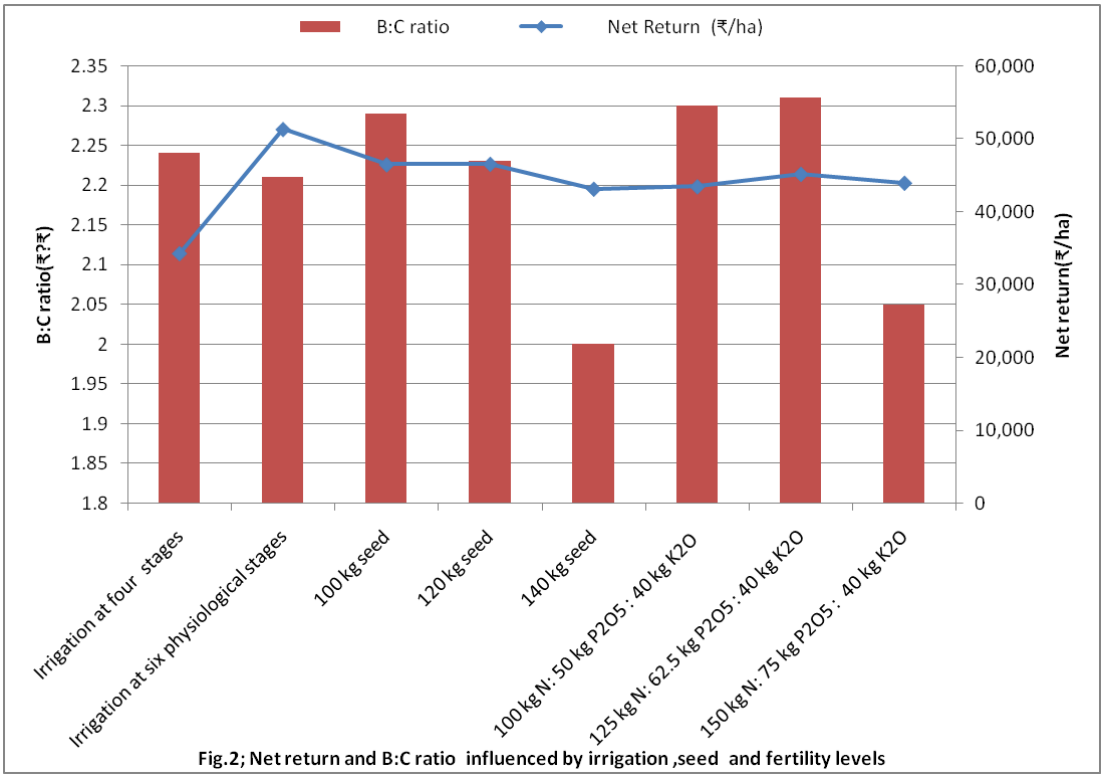

Fig.2; Net return and B:C ratio influenced by irrigation ,seed and fertility levels